

Jillings B. I. III

## (12) UK Patent Application (19) GB (11) 2 115 511 A

(21) Application No 8302809  
 (22) Date of filing 2 Feb 1983  
 (30) Priority data  
 (31) 347809  
 (32) 11 Feb 1982  
 (33) United States of America  
 (US)

(43) Application published  
 7 Sep 1983

(51) INT CL<sup>3</sup>  
 F16B 25/00

(52) Domestic classification  
 F2H 11A6DX 11A7 11AX  
 U1S 13B2 F2H

(56) Documents cited  
 GBA 2078895  
 GBA 2000241  
 GB 1510686  
 GB 1494364  
 GB 0953009

(58) Field of search  
 F2H

(71) Applicant  
 Illinois Tool Works Inc.  
 (USA—Illinois),  
 8501 West Higgins Road,  
 Chicago, Illinois 60631,  
 United States of America

(72) Inventor  
 Kent Buhl Godsted  
 (74) Agent and/or Address for  
 Service  
 Gill Jennings and Every,  
 53—64 Chancery Lane,  
 London WC2A 1HN

(54) Screw anchors for use in  
 masonry

(57) A threaded fastener 10 designed  
 for anchoring embodiment into  
 masonry structures 24 which include  
 relatively hard aggregate. The shank  
 has formed thereon a spaced, helical,  
 continuous thread 12 extending from

the entering portion 13 towards the  
 enlarged head portion 14 for a  
 substantial portion of the length of the  
 shank, the helical thread having a V-  
 shaped cross-sectional configuration  
 with the flanks of the thread  
 intersecting at an included angle  $A_2$  in  
 the range of  $50^\circ$  to  $65^\circ$ , and the  
 helical thread extending about the  
 shank at a lead angle  $A_1$  in the range  
 of  $6^\circ$  to  $8.5^\circ$ . The fastener is inserted  
 with a rotational speed not exceeding  
 250 RPM at torque levels not less  
 than 150 in. lb. (1700 cm N). A  
 second helical thread may be located  
 intermediate the turns of the main  
 thread and have a smaller crest  
 diameter.

Fig. 1

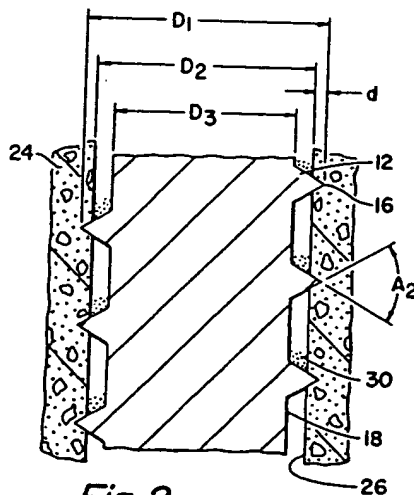
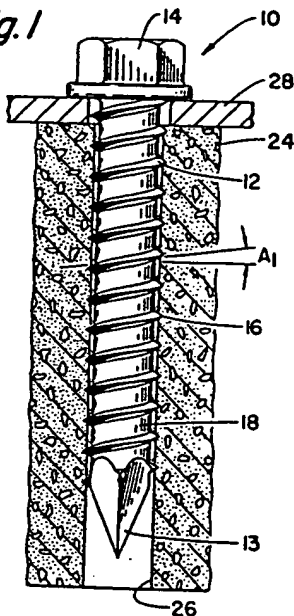
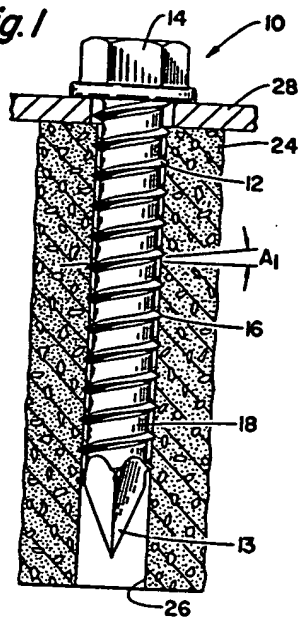


Fig. 2

GB 2 115 511 A

2115511

Fig. 1



1/1

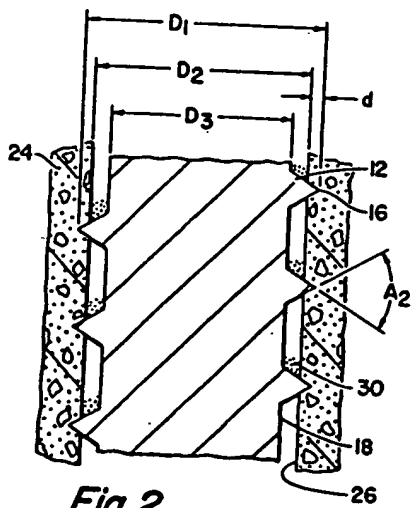


Fig. 2

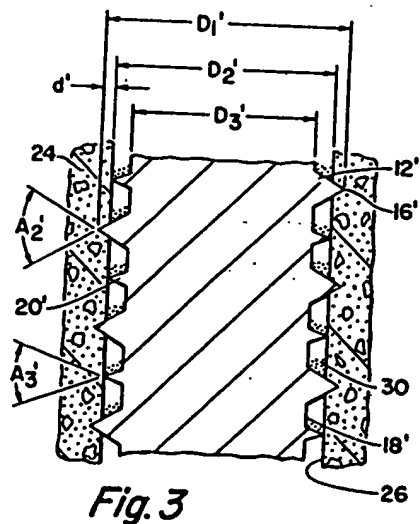


Fig. 3

## SPECIFICATION

## Screw anchors for use in masonry

The present invention relates generally to screw anchors which are designed to be secured within a bore formed in a masonry or concrete structure which structure is formed by utilizing relatively hard aggregate.

The securement of devices, attachments, fixtures etc. to masonry structures has typically utilized stud-like devices which are inserted in a bore or hole preformed in the masonry. The stud-type anchor must in some way be activated to create a wedging or slight embedment within the walls of the masonry to properly provide suitable pull-out strength in such applications. Recent advances in the art of securement to masonry structures have included screw threaded type anchors which threadingly engage the walls of a bore in the masonry or concrete. Examples of these screw anchors are shown in patents such as U.S. Patents Nos. 3 902 399 and 3 937 119.

While anchors of the type generally described in these prior art patents may be suitable for some compositions of masonry or concrete, it has been found that certain geographical areas form concrete or masonry with aggregate of relatively hard materials, such as granite or the like. Such material creates problems, of screw type anchors of the prior art being unable to penetrate the walls of the bore, or very large torque requirements being necessary to embed the threads into the walls. It should be understood that the term masonry used herein is intended to be generic to stone-like building materials and includes but is not necessarily limited to, concrete, brick, fire brick materials, ceramic materials, etc.

It has been found that, even within the crowded art of threaded fasteners, a unique relationship between the several parameters of a threaded fastening system in concrete or masonry exists which will permit such a system to work effectively and efficiently in hard aggregate concrete.

A screw type anchor according to one aspect of the invention is for retention in a bore of predetermined diameter formed in a masonry type support surface, and the anchor includes an axially extending shank with an enlarged head portion at one extremity and a bore entering portion at the opposite extremity, the head portion including rotation inducing surfaces; the shank having formed thereon a spaced, helical, continuous thread extending from the entering portion towards the enlarged head portion for a substantial portion of the length of the shank, the helical thread having a V-shaped cross-sectional configuration with the flanks of the thread intersecting at an included angle in the range of 50° to 65°, and the helical thread extending about the shank at a lead angle in the range of 6° to 8.5°. Such an anchor has been found to penetrate hard aggregate masonry or concrete material using acceptable application torque and provide acceptable pull-out strengths.

Preferably the anchor is used in combination with a support surface wherein the predetermined bore diameter is substantially equal to 0.9 times the crest diameter of the thread of the anchor, so that the average penetration of the crest of the thread into the wall of the bore is substantially 0.05 times the predetermined crest diameter. Such proportions contribute to good pull-out strength using acceptable application torque.

According to another aspect of the invention, a method of securing a screw-type anchor in relatively hard aggregate masonry material includes the steps of accurately forming a bore of predetermined diameter in the masonry, and threadingly engaging the screw type anchor within the bore by axially inserting the anchor with a rotational speed not exceeding 250 RPM at torque levels not less than 150 in.lb (1700 cm N).

The accompanying drawings serve to illustrate possible embodiments of these aspects of the invention. In these drawings:—

Figure 1 is a side elevational view in partial section of an anchor in a bore in masonry; Figure 2 is a partial, enlarged sectional view taken axially of the anchor and bore; and Figure 3 is a view similar to Figure 2 but with an alternative embodiment of the anchor.

The anchor shown in Figure 1 is a threaded fastener 10 having an elongated shank which includes at least one thread 12 formed thereon. The thread, as will be shown later herein, is created with a predetermined helix angle, pitch and included angle, and includes a sharp pointed crest 16 creating a crest diameter of predetermined value. The fastening system further includes a bore 26 of predetermined diameter formed in a relatively hard aggregate concrete or masonry structure 24. The parameters and dimensions of the system will be described in detail later herein but it should suffice to say that the system is ultimately designed to in some way clamping or fixingly associate a fixture or attachment device 28 to the hard aggregate concrete structure 24.

The threaded fastener 10 further includes a relatively sharp point 13 to facilitate entry into the bore and also includes some form of rotation inducing surfaces on a driving head 14 to enable a user to threadingly insert the fastener in the hard aggregate material, through the application of torque with known tools.

In the development of this invention it has been found that the included angle of the thread form 12 is an important consideration in the design of the total system. A thread form 12 with a sharp apex 16 should create a V-shaped thread cross-sectional configuration with the flanks of the thread intersecting at an included angle, shown in the drawings as  $A_2$ , which should be in the range of 50° to 65°. With this rather large included angle of the thread, the thread has sufficient durability and strength

to penetrate hard aggregate material, as compared to the rather sharp-crested 30° to 40° threads which have been suggested for use in conventional aggregate materials. The selection of the thread angle  $A_2$  is one of the vital parameters in this threaded system, in that the thread angle must not be so small, and the thread thus weak, as to be mutilated or bent when applied and permit little or no penetration in hard aggregate material, nor so large as to require installation torques that are excessive and which could lead to torsional failure of the anchor.

A further vital parameter in the design of the hard aggregate securement system is the thread helix or lead angle which is shown as  $A_1$  in Figure 1. It has been found that this angle  $A_1$  should be in the range of 6° to 8.5°. This range for the helix angle parameter has been found to be sufficient in the hard aggregate material. It has further been found that if the helix angle is smaller than 6° the fastener has a tendency to strip or deform the threads created in the bore. Even though the fastener threads may be able to penetrate the concrete or masonry, the combined rotative or axial forces of the fastener on the concrete may create excessive pressures on the thread formed in the concrete, causing the internal thread to crumble, and eliminate the threaded engagement. Conversely if the helix angle is greater than 8.5° the torque to embed the fastener in the concrete will be too great for normal commercial application equipment and could possibly lead to torsional failure of the anchor.

A third important relationship, in a system designed to enable an anchor to penetrate and hold in hard aggregate material, is the extent of penetration of the crest 16 of the thread 12 of the fastener. A particular relationship between the crest diameter  $D_1$  and the bore diameter  $D_2$  has been found to be highly desirable in conjunction with the above two parameters, namely, the included angle of the thread and the helix angle. It has been found that if the depth of engagement "d" shown in Figure 2 is substantially 0.05 times  $D_1$  (crest diameter) then the combination effect of the unique relationship of the specific parameters "d",  $D_1$ ,  $D_2$ ,  $A_1$  and  $A_2$  will not only permit the threaded fastener to be engaged tightly within the hard aggregate walls, but will permit the fastener to be driven without mutilation or harm to either the concrete structure or to the threads. While it may appear that a much greater engagement is required for maximizing the effectiveness of the fastening system, it must be understood that such a maximum depth of engagement may not at all be feasible or practical, since it is to be accomplished using relatively standard thread engagement techniques which may require abnormally high torque. Thus it has been determined that the penetration value of 0.05 times  $D_1$  provides a reliable completed fastening system within the requirements of presently available materials for fasteners and applying machine technology. It should thus become apparent that the fastening system is desirably designed so that the bore diameter  $D_2$  is substantially 0.9 times the value of the crest diameter  $D_1$ .

A further parameter of the system which has been found to be important is the number of pitches of threads that are embedded in the concrete, i.e., essentially the axial penetration of the threaded shank into the bore. It has been found that at least 6 pitches of such an embedded thread in a system designed with the above parameters is desirable to provide acceptable pull-out strength of the anchor.

The threads per unit length design parameter, while related to the lead angle  $A_1$ , is also included in specific examples of fastening systems designed in accordance with this invention. It has been found that the optimum threads per unit length value, as well as the helix angle value, decreases as the nominal diameter of the fastener increases.

Specific examples of fastening systems designed in accordance with this invention are as follows:

~7/32 inch (0.210 inch; 0.533cm)		Nominal anchor diameter
Crest diameter	0.210 inch (0.533 cm)	
Helix angle	7.8°	
Depth of thread engagement	0.01 inch (0.025 cm)	
Threads per inch	11 (4.3 per cm)	
Thread included angle	60°	

	1/4 inch (0.250 inch; 0.635 cm)	Nominal anchor diameter
	Crest diameter	0.250 inch (0.635 cm)
	Helix angle	7.25°
	Depth of thread engagement	0.0125 inch (0.032 cm)
5	Threads per inch	10 (3.95 per cm)
	Thread included angle	60°

5

	5/16 inch (0.313 inch; 0.795 cm)	Nominal anchor diameter
	Crest diameter	0.313 inch (0.795 cm)
	Helix angle	7.20°
10	Depth of thread engagement	0.016 inch (0.041 cm)
	Threads per inch	8 (3.15 per cm)
	Thread included angle	55°

10

	3/8 inch (0.375 inch; 0.952 cm)	Nominal anchor diameter
	Crest diameter	0.375 inch (0.952 cm)
15	Helix angle	6.9°
	Depth of thread engagement	0.020 inch (0.051 cm)
	Threads per inch	7 (2.75 per cm)
	Thread included angle	55°

15

20 The reasons for the unique effective relationships between the parameters noted above are not entirely known, but it is believed that it is a combination of the parameters to provide the optimum surface engagement between the threads and the masonry or concrete without substantially increasing the torque requirements and maximizing the pull-out strength of the complete joint. 20

25 The root diameter  $D_2$  must also be a part of the complete dimensioning of the system, and it has been determined that a relationship between crest diameter  $D_1$  and the root diameter  $D_2$  should be such that  $D_2$  is substantially 0.75 times  $D_1$  to provide the necessary space between the threaded fastener 10 and the walls of the concrete bore 26. The dust or debris 30 developed during the embedment of the fastener also creates an important ingredient in the fastening system, and the distance between the root diameter  $D_3$  and the bore diameter  $D_2$  must be designed to collect the dust and to provide a sufficient amount of compaction of the dust which acts as a secondary frictional securement force within the system. 30

35 Further parameters found to be important in providing an adequate fastening system for hard aggregate masonry are the rotational speed and torque applied to the anchor during insertion in the bore. Typical rotational speeds of equipment generally used in driving threaded fasteners or in hammer drills are in the neighbourhood of 1500 RPM. It has been found that anchors of the type described herein are advantageously applied at speeds and torques which would be considered in the art as low speeds and high torques. For example, a rotational speed not exceeding 250 RPM in conjunction with torque generally not less than 150 in.lb. (1700 cm N) provides a properly secured anchor. 35

40 Turning to Figure 3, an alternative embodiment of the fastening system is shown wherein like reference numerals designate like elements with the addition of the "prime" notation. In this embodiment a second helical thread 20' is shown to be positioned intermediate the turns of the primary thread 12'. This thread 20' has a V-shaped cross-sectional configuration with the flanks of the second thread intersecting at a much sharper included angle shown as  $A'_3$ . Preferably this is in the range of 30° to 55°. With this smaller included angle the amount of dust or concrete debris 30 can be maximized and yet provide a stabilizing influence in the system by centring the device and thus maximizing efficiency and effectiveness of the total system described above. 45

45

While many of the parameters above for specifically designed systems may be found individually in some prior art threaded devices, it is submitted that the specific parameters for each specific system taken in a composite produce a new and unexpected result in the embedment of threaded fasteners in hard aggregate concrete.

## 5 CLAIMS

5

1. A screw type anchor for retention in a bore of predetermined diameter formed in a masonry type support surface, the anchor including an axially extending shank with an enlarged head portion at one extremity and a bore entering portion at the opposite extremity, the head portion including rotation inducing surfaces; the shank having formed thereon a spaced, helical, continuous thread extending from the entering portion towards the enlarged head portion for a substantial portion of the length of the shank, the helical thread having a V-shaped cross-sectional configuration with the flanks of the thread intersecting at an included angle in the range of 50° to 65°, and the helical thread extending about the shank at a lead angle in the range of 6° to 8.5°. 10
2. A screw type anchor according to claim 1, wherein the threads per inch and crest diameter of the thread are respectively, substantially 11 and 0.210 inches (4.3 per cm and 0.533 cm). 15
3. A screw type anchor according to claim 1, wherein the threads per inch and crest diameter of the thread are respectively, substantially 10 and 0.250 inches (3.95 per cm and 0.635 cm).
4. A screw type anchor according to claim 1, wherein the threads per inch and crest diameter are respectively, substantially 8 and 0.313 inches (3.15 per cm and 0.795 cm). 20
5. A screw type anchor according to claim 1, wherein the threads per inch and crest diameter are respectively, substantially 7 and 0.375 inches (2.75 per cm and 0.952 cm).
6. A screw type anchor according to any of claims 1 to 6, wherein the continuous thread extends a distance of at least six pitches along the shank.
7. A screw type anchor according to any of claims 1 to 6, in combination with the support surface, wherein the predetermined bore diameter is substantially equal to 0.9 times the crest diameter of the thread of the anchor, so that the average penetration of the crest of the thread into the wall of the bore is substantially 0.05 times the predetermined crest diameter. 25
8. A screw type anchor according to claim 7, wherein the shank has formed thereon a second helical continuous thread, extending from the entering portion towards the enlarged head portion for a substantial portion of the length of the shank, the second helical thread having a crest diameter less than the predetermined crest diameter of the first thread and substantially equal to the predetermined diameter of the bore, and having a V-shaped cross-sectional configuration with the flanks of the second thread intersecting at an included angle in the range of 30° to 55°. 30
9. A method of securing a screw-type anchor in relatively hard aggregate masonry material including the steps of accurately forming a bore of predetermined diameter in the masonry, and threadingly engaging the screw type anchor within the bore by axially inserting the anchor with a rotational speed not exceeding 250 RPM at torque levels not less than 150 in.lb (1700 cm N). 35
10. A method according to claim 9, wherein the screw-type anchor has a thread crest diameter such as to provide a bore diameter/crest diameter relationship of substantially 0.9 to 1. 40
11. A method according to claim 10, wherein the helical angle of the thread on the anchor is in the range of 6° to 8.5°, and the flanks of the threads intersect at an included angle of 50° to 65°.
12. A method according to claim 10, wherein the anchor is threadingly inserted in the bore a distance of at least 6 pitches.